U.S. DEPARTMENT OF COMMERCE

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Gasohol Test Program

(U.S.) Environmental Protection Agency
Ann Arbor, MI

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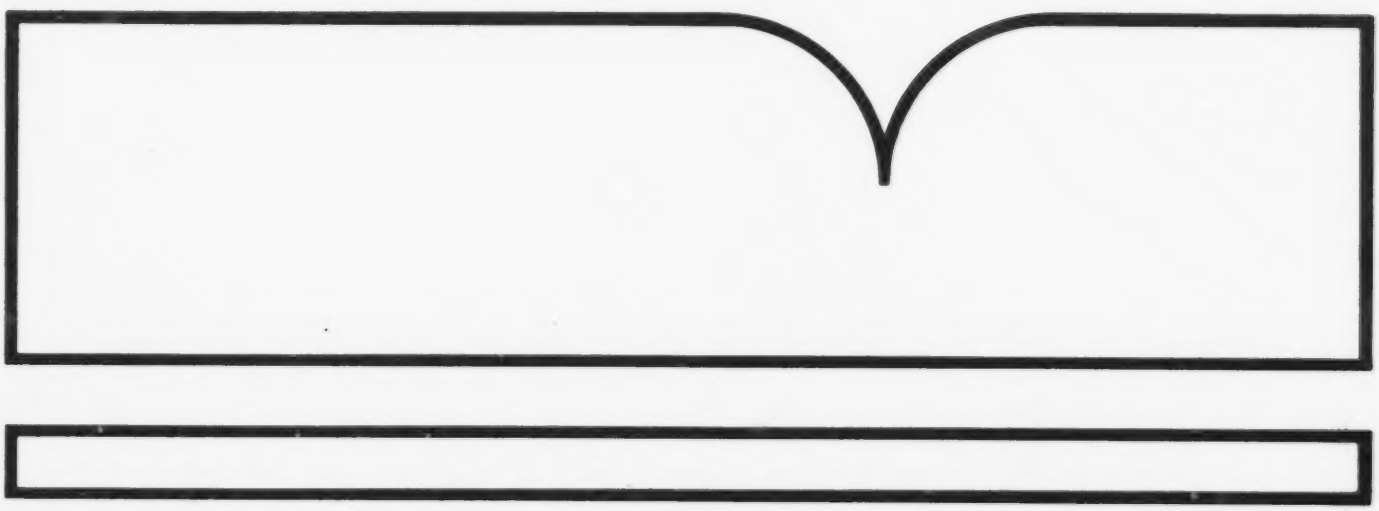

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Gasohol Test Program

by

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16. ABSTRACT

A request for a waiver to permit use of ten percent Ethanol in gasoline ("gasohol") was considered by EPA-Mobile Source Enforcement Division (MSED). The Emission Control Technology Division (ECTD) in Ann Arbor, Michigan was requested to assist MSED by testing ten vehicles on two gasoline fuels and three gasohol fuels. In addition, ECTD directed Southwest Research Institute (a contractor laboratory) to test three vehicles on the five fuels plus other fuels containing methyl tertiary butyl ether (MTBE) and tertiary butyl alcohol (TBA), other fuel additives for which waivers have been requested. EPA-ORD was requested to provide more extensive emission data on two test vehicles.

Since the completion of the ECTD test program described in this report, EPA has acted to allow the use of ten percent ethanol in gasoline. Future control of this or other fuel additives is authorized under Section 211 of the 1977 Amendments to the Clean Air Act.

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Addendum

A. Gasohol Waiver Decision

Since the completion of the test program described in this report, EPA has acted to allow the use of 10% ethanol in gasoline. Future control of this or other fuel additives is authorized under Section 211 of the 1977 Amendments to the Clean Air Act.

B. Air Quality Impact of 100% Gasohol Use

Because of the net increase in HC emissions, (caused by a large increase in evaporative HC emissions) use of gasohol produced by adding ethanol to finished gasoline is predicted to cause slightly greater than a 3% increase in oxident levels and a decrease in ambient CO levels of 27% in 1985, dropping to 5% by 1990 relative to ambient levels if gasohol were not used.

These predictions are based on the assumptions that:

1. 100% of the fuel used in a given air quality region is gasohol. This could occur if state tax incentives attract more gasohol to that state than would otherwise be used.

2. Three-way catalyst vehicles with feedback fuel systems predominate the market starting in 1981.

3. Casohol production by adding ethanol to finished gasoline without adjusting base fuel volatility continues.

4. No effort is made by auto manufacturers to improve evaporative HC emission control to compensate for the increased volatility of gasohol.

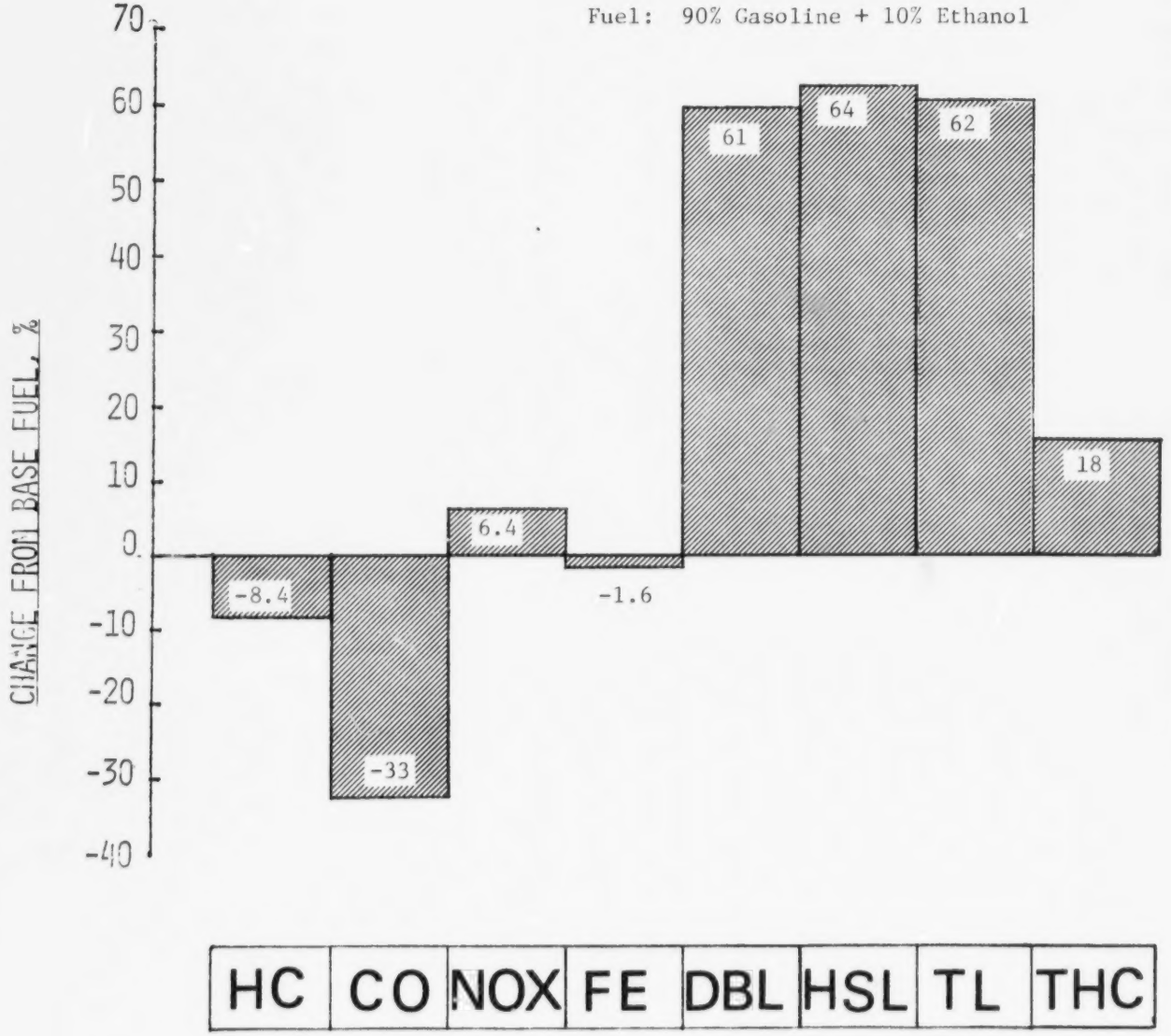
C. Other Changes to this Report:

1. Test vehicle information has been consolidated to a single table in Appendix C.

2. A figure summarizing the emissions data for the eleven test vehicles (7 oxidation catalyst vehicles and 4 three-ways) is included in this addendum.

EMISSIONS SUMMARY - ALL VEHICLES

Fuel: 90% Gasoline + 10% Ethanol



Introduction

A request for a waiver to permit use of 10% Ethanol in gasoline ("gasohol") is being considered by EPA-Mobile Source Enforcement Division (MSED). The Emission Control Technology Division (ECTD) in Ann Arbor, MI was requested to assist MSED by testing ten vehicles on two gasoline fuels and three gasohol fuels. In addition, ECTD directed Southwest Research Institute (a contractor laboratory) to test three vehicles on the five fuels plus other fuels containing MTBE and TBA.[1/] EPA-ORD was requested to provide more extensive emission data on two test vehicles.

The Administrator's decision must be made within 180 days of receipt of the application for waiver otherwise the waiver is automatically granted.[2/] The decision date for this waiver is December 16, 1978. Testing support from MSAPC was requested on September 28, 1978. Vehicles and fuel were acquired and vehicle tests began October 16 and were completed on November 20. Because of the limited time available, duplicate tests of each vehicle/fuel combination were planned with retesting for void tests to be done only on a time available basis.

Summary

Eleven vehicles (4 three-way systems and 7 oxidation catalyst systems) were tested on five fuels. A summer grade gasoline was selected as the base fuel and was used both before and after testing on the two commercial gasohols. Indolene and a gasohol fuel containing Indolene and Ethanol were the other two fuels. All gasohol fuels used in this program contained 10 percent Ethanol (by volume). Duplicate tests were planned on four fuels and four tests were planned on the base fuel.

The test procedure was similar to the standard FTP test normally run on certification vehicles. Some deviations from this procedure were required in order to acquire additional data, such as cannister weights. Also, void test criteria were adjusted when appropriate and when engineering judgement could be used to verify the integrity of the results.

In the following list comparisons of each gasohol fuel are made with the appropriate base fuel:

1. Gasohol fuels increased evaporative HC emissions an average of 49 to 62% on the eleven vehicles tested.

2. The two mixed gasohol fuels (gasoline mixed with 10% Ethanol) decreased exhaust HC by about 9% on all vehicles. The blended gasohol fuel (gasoline blended with 10% Ethanol for correct volatility) increased exhaust HC by an average of 24% on all vehicles.

3. Total HC (evap. & exhaust) for 3.3 trips per day increased 11 to 32 percent with the gasohol fuels.

1/ Methyl tertiary butyl ether and tertiary butyl alcohol are other fuel additives for which waivers have been requested.

2/ Sec. 211(f)(4) of the 1977 Clean Air Act Amendments

4. Evaporative emissions contained about 0.6 grams Ethanol and 3.3 to 5.4 grams HC (as $CH_{1.85}$) with the gasohol fuels.[3/]

5. CO emissions decreased 20 to 34 percent with the gasohol fuels.

6. NOx emissions increased 6 to 11 percent with the gasohol fuels.

7. Fuel economy (by carbon balance) decreased 1 to 5 percent with the gasohol fuels.

8. Driveability complaints increased with the gasohol fuels.

9. Three-way catalyst systems were not appreciably different from oxidation catalyst systems in exhaust and evaporative emission sensitivity to gasohol fuels.

10. It is not known if a gasoline fuel containing 10 percent Ethanol can be commercially blended to match distillation characteristics of a gasoline fuel containing no Ethanol.

11. It is not known if a "blended" gasohol with volatility characteristics similar to a gasoline would give driveability or evaporative emission levels similar to the gasoline.

Test Procedure

The test procedure agreed upon for the ECTD program was to test each vehicle twice on each fuel using the standard FTP with SHED procedure as used for certification tests. Some modifications were necessary to allow for cannister weights to be taken before and after the Diurnal Breathing Loss (DBL) test and after the Hot Soak (HS) test.

Void test criteria normally applied to certification tests were waived for some tests where engineering judgment could be used to verify that the test results were valid for the purpose of this program. Typical examples of this include tests where a heat build for diurnal emissions might be one degree (F) out of tolerance or tests where an exhaust emission analyzer might respan 3-4 percent low when the tolerance is ±2 percent.

Some portions of the FTP were made more restrictive to provide more repeatable SHED results.

-The overnight soak tolerance of 12-36 hours was adjusted to 12-24 hours.

-Two preconditioning driving cycles with a one hour hot soak between them and refueling prior to each cycle were required each time the fuel type was changed.

3/ Ethanol was measured during 12 Diurnal and 10 Hot Soak Tests. The HC reported here corresponds to those tests and is corrected for Ethanol response to the FID.

The complete test procedure is shown in Appendix A. Six vehicles could be run each day using two SHED and two chassis dynamometers. The vehicles were separated into two groups. The first group followed the fuel sequence of 1,2,3,4,5,3 with duplicate tests each time. The second group followed the fuel sequence of 3,4,5,3 and then fuels 1 and 2 if time permitted. Nearly all vehicles did receive duplicate tests on all fuels.

Fuels

Five fuels were chosen for comparison as follows:

Fuel 1: Indolene

Fuel 2: 90% Indolene (same fuel batch as fuel no. 1) plus 10% Ethanol

Fuel 3: Summer grade gasoline (SG)

Fuel 4: 90% Fuel 3 plus 10% Ethanol

Fuel 5: Blended gasohol containing 10% Ethanol and approximating the RVP and distillation characteristics of fuel no. 3

The reason for running Fuels 1 and 2 was to show the changes in emissions which result when the certification fuel is combined with Ethanol thus increasing fuel volatility.

Fuel 3 was selected as a base fuel which might be representative of National average summer grade fuel.

Fuel 4 shows the effect on emissions when Ethanol is added to Fuel 3 as might be done by a fuel retailer or distributor. Fuel 4 volatility is higher than Fuel 3.

Fuel 5 was to be a gasohol blend with RVP and distillation curve similar to Fuel 3. It is not known if this fuel is representative of what a commercial gasohol would be if it were blended by the refiner to meet market requirements. Because Ethanol significantly alters the distillation curve it was difficult to blend a gasohol fuel to meet the distillation curve of a gasoline fuel.

All fuels were ordered by MSED from Howell Hydrocarbons. However, because of time constraints EPA-ECTD started testing on in-house Indolene (Fuel 1) and blended Fuel 2 using Fuel 1 and locally purchased Ethanol. Fuels 3,4, and 5 were supplied by Howell Hydrocarbons. Fuel 5 was found to be out of tolerance and was not used. It was replaced by Howell Hydrocarbons and the replacement was designated Fuel 6.

A fuel sample was drawn from a fuel cart each time the cart was refueled. Since the fuel cart capacity is 50 gallons there is at least one fuel sample for every 55 gallon drum of fuel supplied by MSED. About half of

these samples have been analyzed by EPA-MVEL, Ethyl Corporation, or Petroleum Specialities, Inc. Typical fuel inspection data is included in Appendix B. Figure 1 shows typical distillation data of the five fuels used at EPA-MVEL.

By comparing Fuel 2 with Fuel 1 or Fuel 4 with Fuel 3 the increase in volatility caused by the addition of 10% Ethanol can be seen. Fuel 6 compared with Fuel 3 illustrates the difficulty encountered in trying to blend a "gasohol" to the same distillation curve as a typical gasoline.

A comparison of volatility characteristics of the two gasolines used in this program with D.O.E. fuel survey inspection data for typical summer grade gasoline and for Southern California gasoline is shown in Figure 2.

Vehicles

All vehicles were supplied by the vehicle manufacturers. Ten 1978 and 1979 vehicles were to be run. To ensure completion of ten vehicles in the required time eleven were requested from manufacturers. All eleven were received and all completed the test sequence.

All eleven vehicles were catalyst equipped - 4 with three-way catalysts and 7 with oxidation catalysts. The vehicles included four from Ford (2 three-way catalysts and 2 oxidation catalysts); four from GM (2 three-way catalysts and 2 oxidation catalysts); two from Chrysler; and 1 from Toyota. Vehicle information sheets are included in Appendix C.

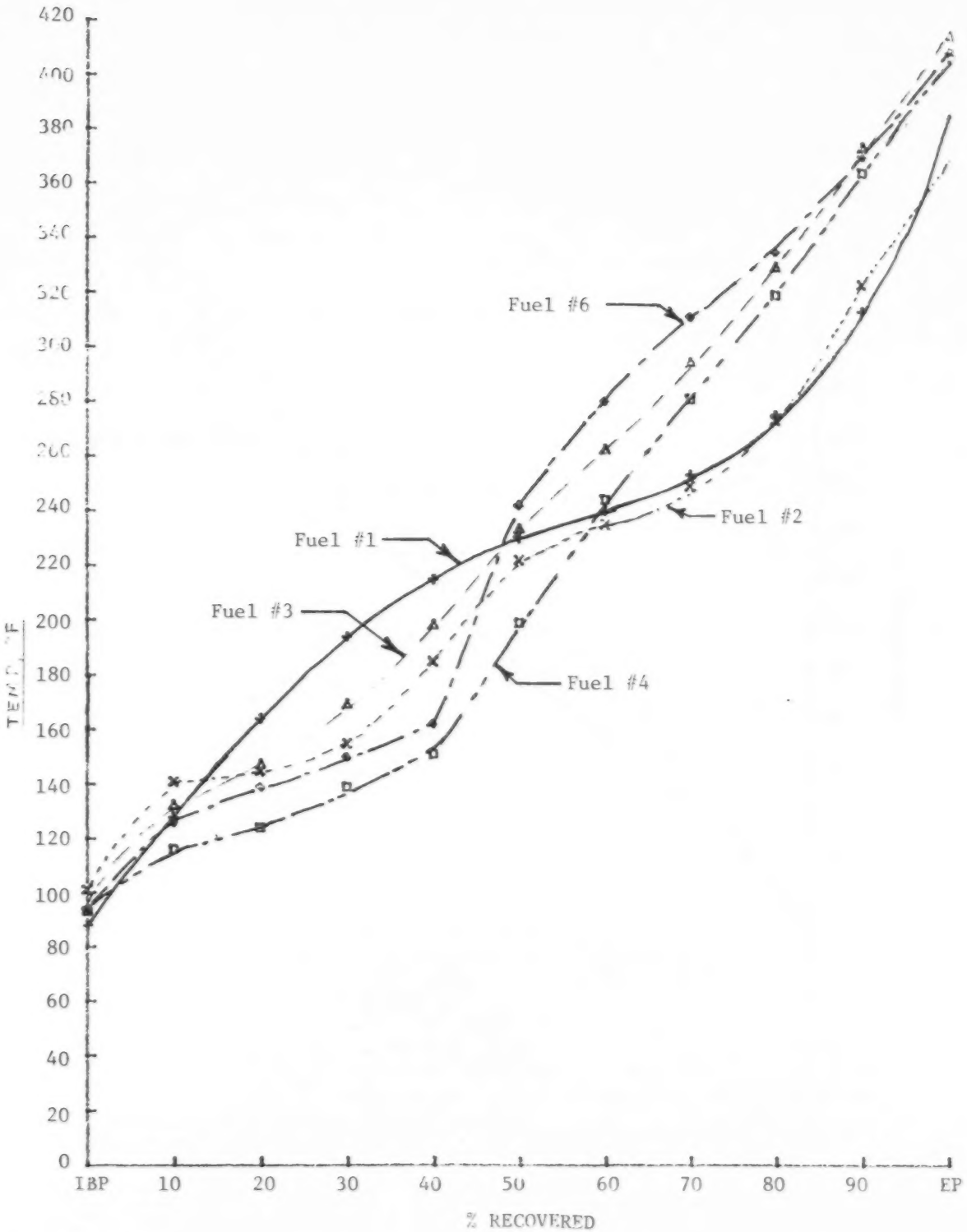
Data and Discussion

The data has been summarized and emissions on each gasoline and gasohol fuel are shown in Figures 3, 4, and 5. The total hydrocarbon exhaust plus evaporative emissions for 3.3 trips per day are designated "TOTHC". DEL, HSL, and TLOSS are the diurnal, hot soak, and total evaporative emissions, respectively.

Emissions and fuel economy for Indolene with 10 percent Ethanol are compared with Indolene and the two "commercial" gasohols are compared with the SG base fuel (Fuel 3) for all vehicles (Figure 6). The gasohol fuels increased both diurnal and hot soak evaporative emissions by 29 to 71 percent. Total evaporative emissions increased by 49 to 62 percent on gasohol fuels. Total HC emissions (evap. plus exhaust) increased by 11 to 32 percent on gasohol fuels. CO emissions decreased 20 to 34 percent and fuel economy decreased 1 to 5 percent on gasohol. NOx increased 6 to 11 percent on gasohol fuels.

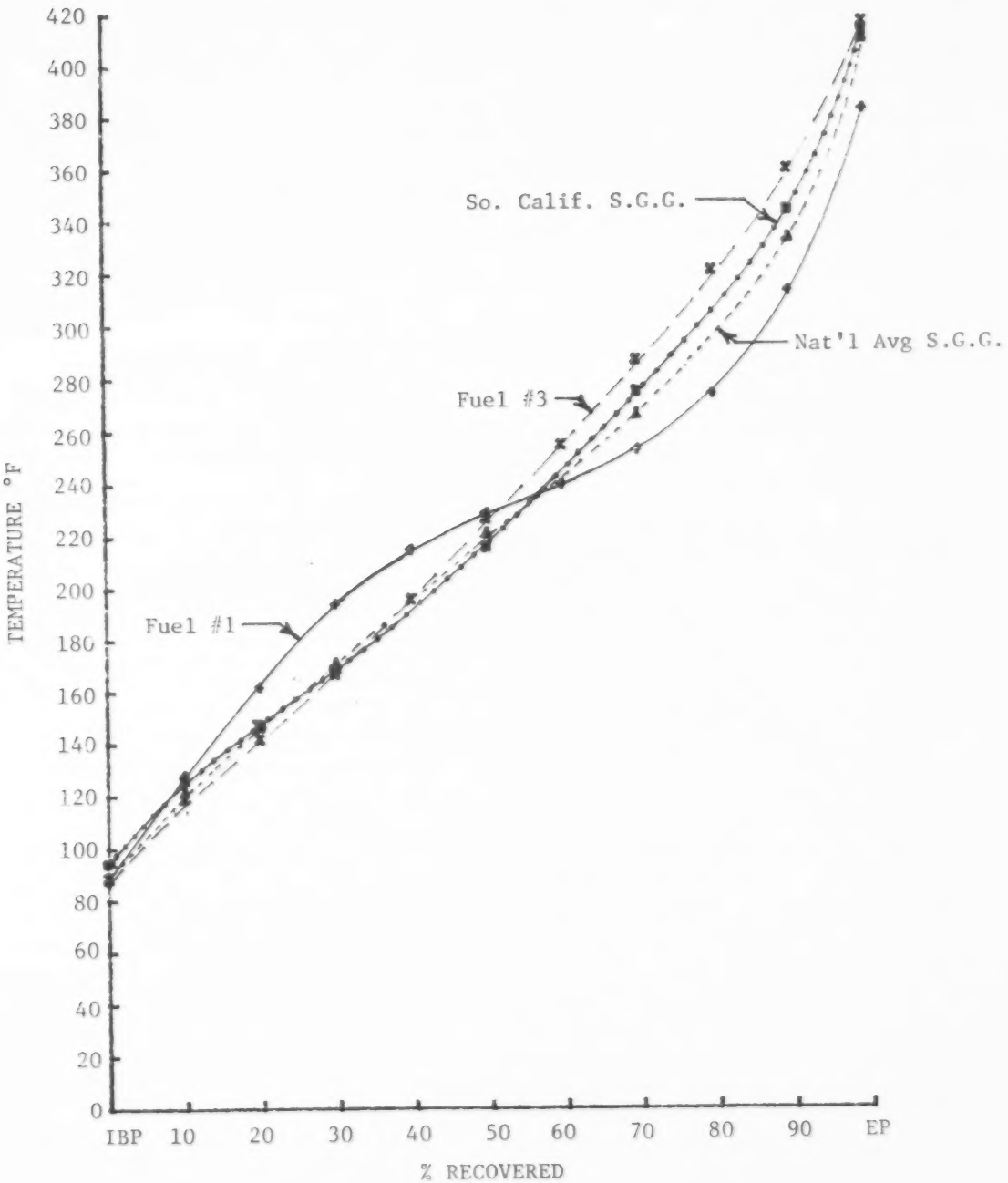
Evaporative emissions with Fuel 6 (blended gasohol) were slightly lower than with Fuel 4 but HC and CO exhaust emissions were higher on Fuel 6 than on Fuel 4. The total HC (exhaust plus evap) for 3.3 trips per day were higher. Fuel 4/3 showed an 18 percent increase and Fuel 6/3 showed a 32 percent increase in total HC emissions.

FIGURE 1. COMPARISIONS OF DISTILLATION CURVES OF TEST FUELS



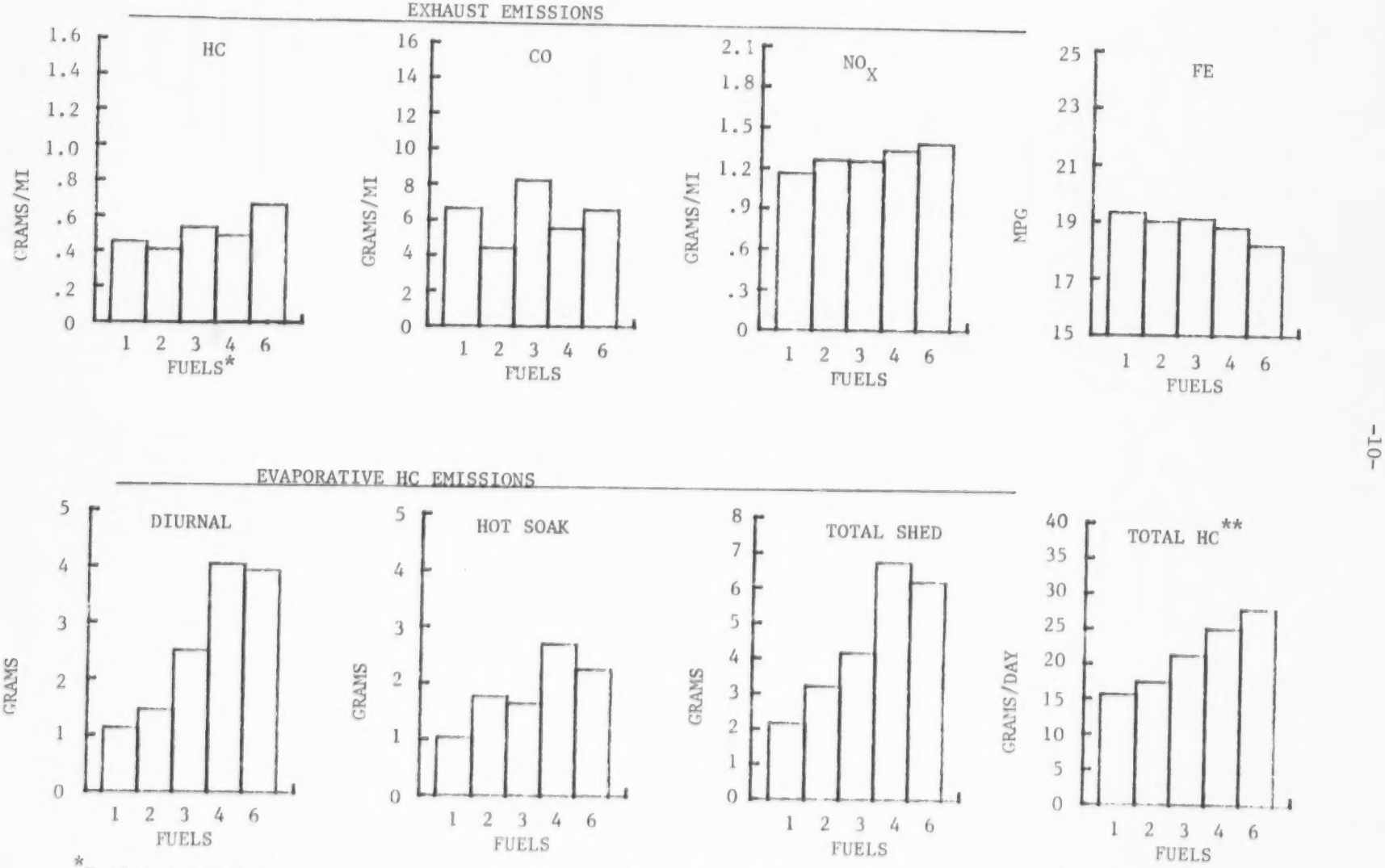
Fuels: 1. Indolene (RVP=9.0)
2. Indolene + 10% Ethanol (RVP=9.2)
3. Commercial Gasoline (RVP=10.0)
4. 90% Fuel 3 + 10% Ethanol (RVP=10.7)
6. Blended Gasohol containing 10% Ethanol (RVP=10.0)

FIGURE 2. COMPARISONS OF TEST FUELS WITH NATIONAL AVERAGE DATA



Fuels: (Fuel 1.) Indolene (RVP=9.0)
(Fuel 3.) MSED Test Fuel (RVP=10.0)
DOE Nat'l Avg. Summer Grade Gasoline (RVP=9.8)
DOE Southern California Summer Grade Gasoline (RVP=8.4)

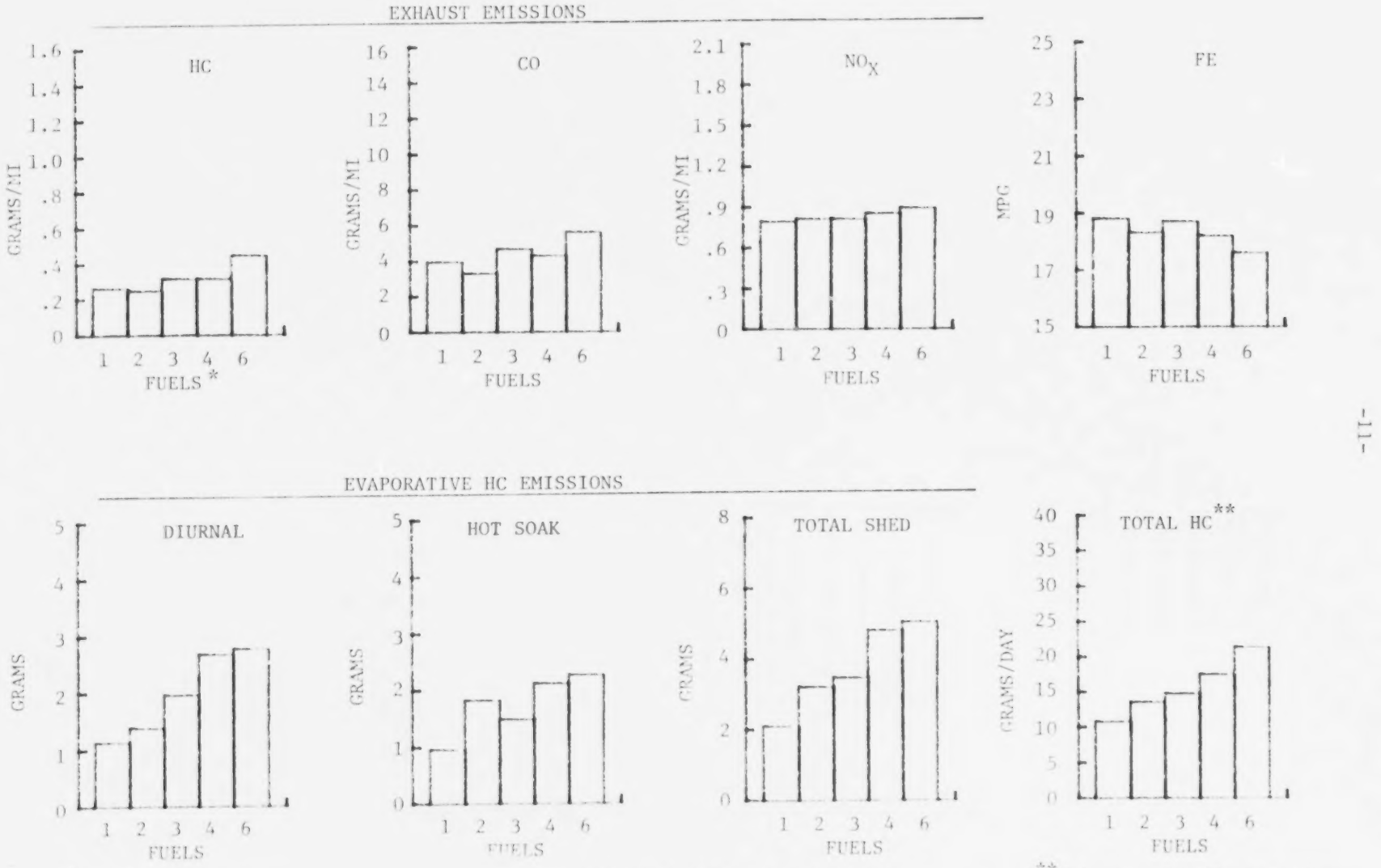
FIGURE 3. AVERAGE EMISSIONS OF 11 1978-79 CATALYST VEHICLES.



*Fuels: 1. Indolene
2. Indolene plus 10% Ethanol
3. Commercial Gasoline
4. 90% Fuel 3 + 10% Ethanol
6. Blended Gasohol containing 10% Ethanol

**Exhaust plus Evaporative Emissions for 3.3 trips per day.

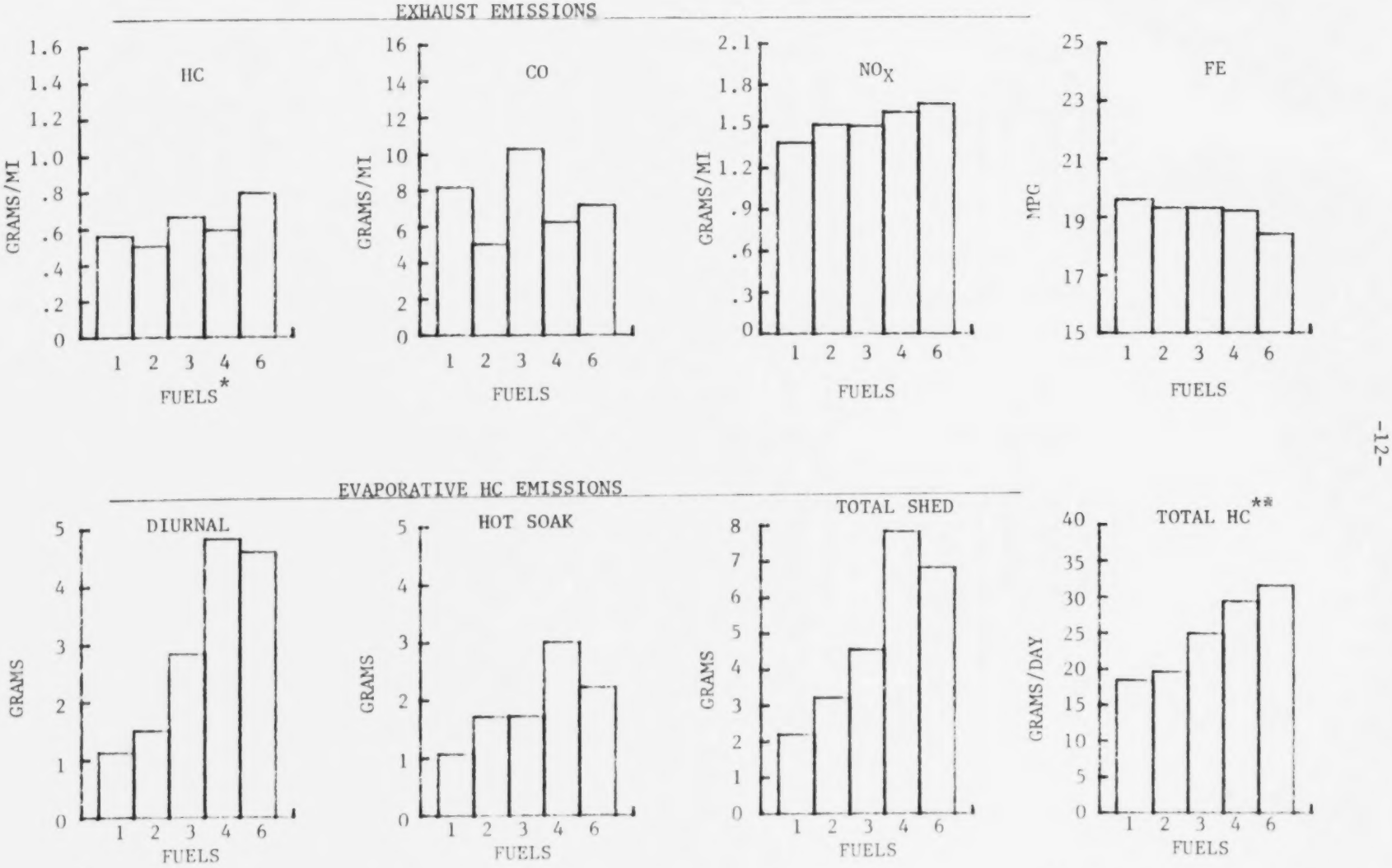
FIGURE 4. AVERAGE EMISSIONS OF 4 1978-79 THREE-WAY CATALYST VEHICLES



*Fuels: 1. Indolene
2. Indolene plus 10% Ethanol
3. Commercial Gasoline
4. 90% Fuel 3 plus 10% Ethanol
6. Blended Gasohol containing 10% Ethanol

**Exhaust plus Evaporative Emissions for 3.3 trips per day.

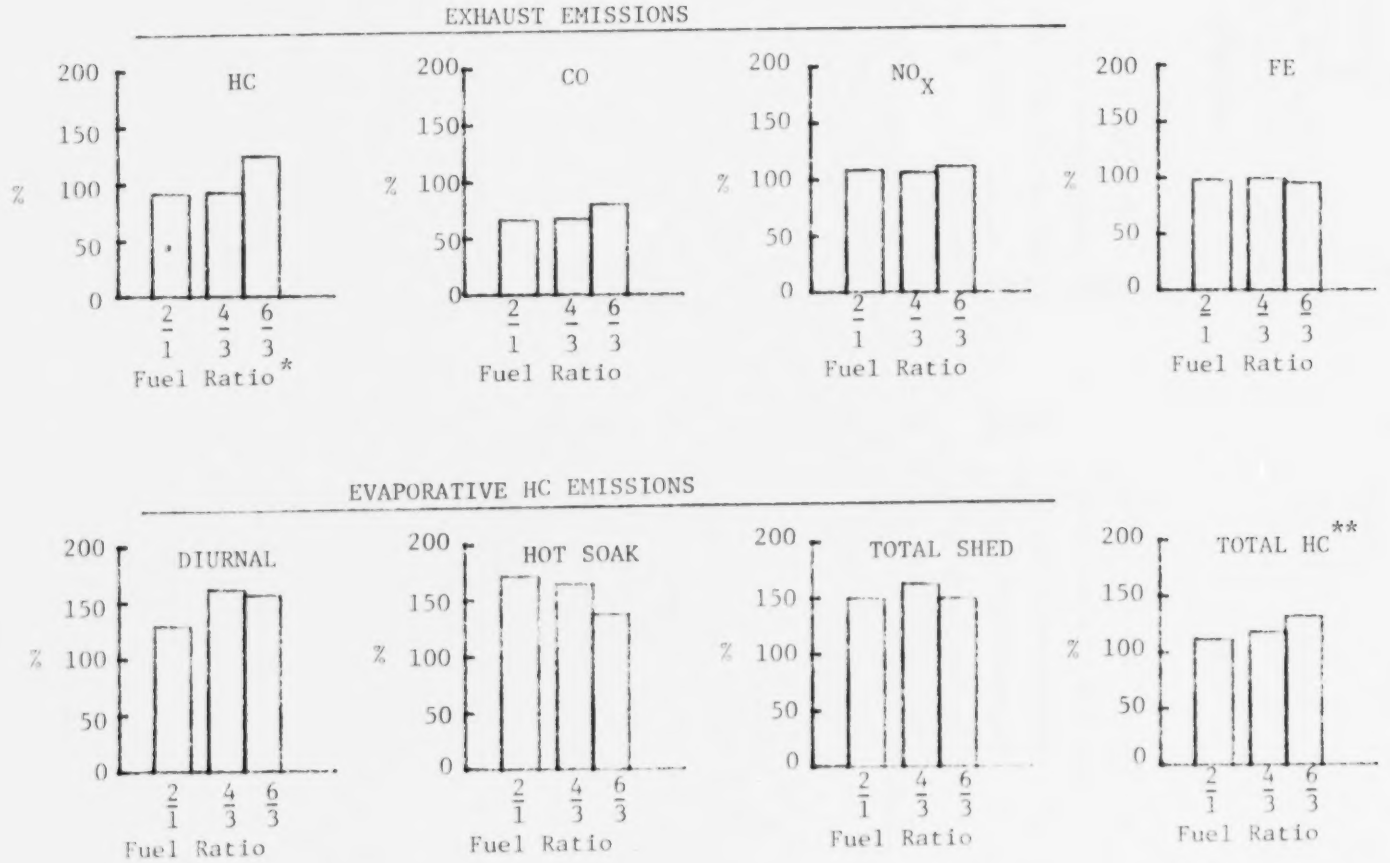
FIGURE 5. AVERAGE EMISSIONS OF 7 1978-79 OXIDATION CATALYST VEHICLES.



*Fuels: 1. Indolene
2. Indolene plus 10% Ethanol
3. Commercial Gasoline
4. 90% Fuel 3 plus 10% Ethanol
6. Blended Gasohol containing 10 % Ethanol

**Exhaust plus Evaporative Emissions for 3.3 trips per day.

FIGURE 6. RATIOS OF AVERAGE EMISSIONS OF 11 1978-79 CATALYST VEHICLES.



*Fuels: 1. Indolene
2. Indolene plus 10% Ethanol
3. Commercial Gasoline
4. 90% Fuel 3 plus 10% Ethanol
6. Blended Gasohol containing 10% Ethanol

**Exhaust plus Evaporative Emissions for 3.3 trips per day.

The fuel inspection data shows that gasohol fuels blended by adding Ethanol to a base gasoline are more volatile than the base fuel. The increased RVP and front end volatility of gasohol would be expected to increase diurnal and hot soak losses, respectively. The oxygen present in alcohol causes leaner operation and would be expected to decrease exhaust HC and CO, unless other fuel characteristic changes such as density, viscosity, or volatility were dominant.

Vehicle emission data supports the above relationships:

1. Higher RVP gave higher diurnal losses.
2. Increased front end volatility (up to 50% point) increased hot soak losses.
3. Gasohol generally gave lower HC and CO exhaust emissions than gasoline.

One exception was Fuel 6 - a blended gasohol. Driveability was poor with stumbling, hesitation and backfiring during acceleration on some vehicles. The HC emissions were 24% higher on this gasohol than on the base fuel. CO emissions were 20% lower but this is not as great as the 34% decrease in CO emissions seen with the other two gasohols.

The mean emissions, fuel ecnomy, and cannister weights were determined for each vehicle on each fuel. These tables are presented in appendix D. Note that the fuels are shown in the order run in these tables. Summaries showing the average of vehicle means for all vehicles; for the TWC vehicles; and for the oxidation catalyst vehicles are shown in Tables 1,2, and 3, respectively. Here the means for the five fuels, the difference between selected fuels and ratios of the means of selected fuels is given.

The emissions and fuel economy data in these tables was presented in Figures 3,4, and 5. The last 5 columns of each table contain cannister weight data (grams):

BDBL = before diurnal test
ADBL = after diurnal test
AHSL = after hot soak test
DDBL = Δ diurnal (ADBL-BDBL)
DTEST = Δ test (AHSL-BDBL)

Cannister weights could not be measured before the hot soak test without interfering with the test.

The cannister weight gains during the diurnal breathing loss tests (DDBL) are related to the Reid Vapor Pressures of the fuels. The cannister weights before the diurnal test (BDBL) (which is after a 12-24 hour soak) are fuel related but it is not clear which fuel parameter(s) exert the strongest influence.

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

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TABLE 1

GASOHOL PROGRAM DATA SUMMARY

CATALYST TYPES: 3-WAYS AND OX-CATS
NUMBER OF VEHICLES: 11

MEANS OF ALL TESTS		HC	CO	NOX	CO2	FE	DBL	HSL	TLOSS	TOTHC	BDBL	ADBL	AHSL	DDBL	DTEST
		(GRAMS/MILE)				(MPG)	(GRAMS)								
FUEL	N														
FUEL 1	(19)	0.451	6.61	1.16	470.	19.3	1.12	1.02	2.14	15.60	890.	904.	885.	13.3	-4.9
FUEL 2	(21)	0.410	4.39	1.26	467.	19.0	1.45	1.75	3.20	17.35	891.	907.	892.	16.3	1.1
FUEL 3	(41)	0.535	8.20	1.25	472.	19.1	2.51	1.63	4.15	21.11	900.	919.	898.	19.4	-2.1
FUEL 4	(21)	0.490	5.51	1.33	468.	18.8	4.04	2.68	6.72	24.97	905.	927.	908.	21.5	2.7
FUEL 6	(25)	0.665	6.57	1.38	482.	18.2	3.93	2.24	6.17	27.76	905.	924.	905.	19.3	0.6
DIFFERENCES BETWEEN MEANS															
FUEL 2 - FUEL 1		-.041	-2.23	0.09	-3.	-0.4	0.33	0.73	1.06	1.76	1.	4.	7.	3.0	6.0
FUEL 3 - FUEL 1		0.084	1.59	0.08	2.	-0.2	1.39	0.61	2.00	5.52	10.	16.	12.	6.1	2.9
FUEL 4 - FUEL 3		-.045	-2.69	0.08	-4.	-0.3	1.53	1.04	2.57	3.86	5.	8.	10.	2.1	4.8
FUEL 6 - FUEL 3		0.130	-1.63	0.13	10.	-0.9	1.41	0.61	2.02	6.65	5.	5.	7.	-0.1	2.7
RATIOS OF MEANS (%)															
FUEL 2 / FUEL 1		91.	66.	108.	99.	98.	129.	171.	149.	111.	100.	100.	101.	122.	-23.
FUEL 3 / FUEL 1		119.	124.	107.	100.	99.	224.	160.	193.	135.	101.	102.	101.	145.	42.
FUEL 4 / FUEL 3		92.	67.	106.	99.	99.	161.	164.	162.	118.	101.	101.	101.	111.	-131.
FUEL 6 / FUEL 3		124.	80.	111.	102.	95.	156.	137.	149.	132.	101.	101.	101.	100.	-29.

NOTES: 1. TOTHC IS TOTAL HC EMISSIONS (EXHAUST + EVAPORATIVE) FOR 3.3 TRIPS PER DAY.

2. FUEL DESCRIPTIONS-
1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MVEL
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: MOBILE HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: MOBILE HYDROCARBONS (MSED ORDER).
5. BLEND OF GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: MOBILE HYDROCARBONS (MSED ORDER).

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Table 2. GASOHOL PROGRAM DATA SUMMARY PROCESSED: DEC 15, 1978
(REVISION A: DEC. 27, 1978)

CATALYST TYPE: 3-WAYS
NUMBER OF VEHICLES: 4

MEANS OF ALL TESTS		HC	CO	NOX	CO2	FE	DHL	HSL	TLOSS	TOTHC	BDBL	ADBL	AMSL	DURL	DTEST
		(GRAMS/MILE)				(MPG)	(GRAMS)								
FUEL	N														
FUEL 1	(9)	0.262	3.94	0.79	474.	18.8	1.13	0.95	2.08	10.75	954.	969.	944.	15.0	-6.4
FUEL 2	(10)	0.247	3.29	0.81	475.	18.4	1.38	1.81	3.19	13.49	958.	976.	959.	18.3	1.4
FUEL 3	(16)	0.314	4.04	0.81	479.	18.7	1.96	1.48	3.45	14.65	971.	993.	968.	21.7	-2.9
FUEL 4	(8)	0.314	4.26	0.85	477.	18.2	2.67	2.11	4.79	17.41	977.	1002.	979.	25.4	2.1
FUEL 6	(9)	0.445	5.57	0.89	488.	17.6	2.77	2.26	5.03	21.24	977.	999.	978.	21.9	1.1
DIFFERENCES BETWEEN MEANS															
FUEL 2 - FUEL 1		-.015	-0.65	0.03	-4.	-0.5	0.25	0.86	1.11	2.74	3.	6.	11.	3.3	7.8
FUEL 3 - FUEL 1		0.053	0.70	0.02	1.	-0.1	0.83	0.53	1.36	3.90	17.	23.	20.	6.7	3.5
FUEL 4 - FUEL 3		-.001	-0.38	0.04	-3.	-0.5	0.71	0.63	1.34	2.76	5.	9.	10.	3.7	5.1
FUEL 6 - FUEL 3		0.131	0.93	0.07	9.	-1.1	0.80	0.78	1.58	6.60	6.	6.	10.	0.3	4.0
RATIOS OF MEANS (*)															
FUEL 2 / FUEL 1		94.	83.	103.	99.	98.	122.	190.	153.	125.	100.	101.	101.	122.	-21.
FUEL 3 / FUEL 1		120.	118.	103.	100.	100.	174.	156.	165.	136.	102.	102.	102.	145.	46.
FUEL 4 / FUEL 3		100.	92.	105.	99.	97.	136.	142.	139.	119.	101.	101.	101.	117.	-72.
FUEL 6 / FUEL 3		142.	120.	109.	102.	94.	141.	152.	146.	145.	101.	101.	101.	101.	-38.

NOTES: 1. TOTHC IS TOTAL HC EMISSIONS (EXHAUST + EVAPORATIVE) FOR 3.3 TRIPS PER DAY.

2. FUEL DESCRIPTIONS-
   1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
   2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MVEL
   3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
   4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
   6. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

(5. OUT OF SPECIFICATIONS. NOT USED FOR VEHICLE TESTS.)

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

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Table 3. GASOHOL PROGRAM DATA SUMMARY PROCESSED: DEC 15, 1978

CATALYST TYPE: OX-CATS
NUMBER OF VEHICLES: 7

MEANS OF ALL TESTS		HC	CO	NOX	CO2	FE	DBL	HSL	TLOSS	TOTHC	BDBL	ADBL	AHSL	DDBL	DTEST
		(GRAMS/MILE)				(MPG)	(GRAMS)								
FUEL	N														
FUEL 1	(10)	0.559	8.14	1.38	465.	19.6	1.12	1.06	2.18	18.37	854.	866.	850.	12.3	-4.1
FUEL 2	(11)	0.503	5.01	1.51	463.	19.3	1.50	1.71	3.21	19.56	853.	868.	854.	15.1	1.0
FUEL 3	(25)	0.661	10.24	1.50	468.	19.3	2.83	1.72	4.54	24.81	859.	877.	858.	18.0	-1.6
FUEL 4	(13)	0.590	6.22	1.60	464.	19.2	4.82	3.00	7.82	29.29	865.	884.	868.	19.3	3.1
FUEL 6	(16)	0.791	7.14	1.66	477.	18.4	4.59	2.22	6.82	31.49	864.	881.	864.	17.8	0.2
DIFFERENCES BETWEEN MEANS															
FUEL 2 - FUEL 1		-.056	-3.13	0.13	-2.	-0.3	0.38	0.65	1.03	1.19	-1.	2.	4.	2.8	5.1
FUEL 3 - FUEL 1		0.102	2.10	0.12	3.	-0.4	1.71	0.66	2.37	6.44	5.	11.	8.	5.7	2.5
FUEL 4 - FUEL 3		-.071	-4.02	0.11	-4.	-0.1	1.99	1.28	3.27	4.49	6.	7.	10.	1.2	4.6
FUEL 6 - FUEL 3		0.130	-3.10	0.17	11.	-0.8	1.76	0.51	2.27	6.68	4.	4.	6.	-0.2	1.8
RATIOS OF MEANS (%)															
FUEL 2 / FUEL 1		90.	62.	110.	99.	98.	134.	162.	147.	107.	100.	100.	101.	122.	-24.
FUEL 3 / FUEL 1		118.	126.	109.	101.	98.	252.	162.	209.	135.	101.	101.	101.	146.	39.
FUEL 4 / FUEL 3		89.	61.	107.	99.	99.	170.	175.	172.	118.	101.	101.	101.	107.	-195.
FUEL 6 / FUEL 3		120.	70.	111.	102.	96.	162.	130.	150.	127.	101.	100.	101.	99.	-14.

NOTES: 1. TOTHC IS TOTAL HC EMISSIONS (EXHAUST + EVAPORATIVE) FOR 3.3 TRIPS PER DAY.

2. FUEL DESCRIPTIONS-
1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MVEL
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
6. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

(5. OUT OF SPECIFICATIONS, NOT USED FOR VEHICLE TESTS.)

Vehicle operation on the FTP causes a net decrease in cannister weight from after the diurnal test to after the hot soak test (AHSL-ADBL). This indicates that the cannister is purging during the test and that there was plenty of cannister capacity available during the hot soak test. High hot soak losses then imply that the evaporative emission control systems do not effectively trap hot soak emissions on these vehicles. This is an important consideration since hot soak losses are more significant than diurnal losses from an air quality viewpoint. This is because there is only one diurnal per day but an average of 3.3 hot soaks per day per vehicle in "real world" use.

SHED Alcohol Data

Ethanol measurements were made on some evaporative emissions tests. Capability for Ethanol measurement did not exist at EPA-MVEL at the start of this program. The Laboratory Branch, in conjunction with EPA-ORD, was able to provide a gas chromatograph and procedure capable of measuring SHED Ethanol concentrations in time to obtain data part way through the program.

Ethanol emissions from gasohol fuels 4 and 6 for the diurnal and hot soak test ranged from .1 to.6 grams for each test. The average diurnal emissions were 0.26 grams Ethanol on 12 tests and the average hot soak emissions were 0.33 grams Ethanol on 10 tests. This amounts to 0.6 grams Ethanol for a complete test or 1.35 grams Ethanol for 3.3 trips*.

Correcting the SHED FID for response to Ethanol would result in a decrease in SHED HC of about 5 percent for the gasohol fuels. The Ethanol present as determined by the GC would then have to be added to the SHED HC to arrive at the total evaporative HC plus Ethanol emissions. This can not be done directly since HC is given in grams of $CH_{1.85}$ (MW=13.85) and Ethanol is given in grams of C_2H_5OH (MW=46). The reported HC emissions (evaporative and exhaust) are not corrected for Ethanol response of the FID nor for measured Ethanol in the sample.

Driveability

Driveability experiments were not run. However, drivers were requested to note any driveability comments on the test data sheets. These comments indicate a slight degradation in driveability on some vehicles on Fuels 2, 3, and 4. A more severe degradation in driveability on Fuel 6 was noted, with occurrences of backfiring and poor acceleration on several vehicles.

Conclusion

The purpose of this test program was to evaluate the effect on emissions (evaporative and exhaust) that the use of gasohol would have. The data

*3.3 trips per day = DBL X 1.0 + HSL X 3.3

shows that gasohol increased total hydrocarbon emissions by 11 to 32 percent and NOx emissions by 6 to 11 percent while decreasing CO emissions by 20 to 34 percent on the eleven 1978 and 1979 vehicles tested.

Driveability on the blended gasohol (Fuel 6) degraded to the extent that if commercial fuel like Fuel 6 were used it is likely that persons using this fuel would either stop using it or would have their vehicles adjusted to compensate for the different fuel. This would most likely be an air-fuel ratio (A/F) adjustment towards richer operation. Once properly adjusted for gasohol fuel the vehicle exhaust emissions might be expected to be similar to emissions from a vehicle correctly adjusted for and running on gasoline, but evaporative emissions would remain high. However, if a vehicle adjusted for gasohol were then operated on gasoline a rich A/F ratio would result and would likely cause a marked increase in HC and CO emissions while not affecting driveability.

Driveability comments on Indolene plus 10 percent Ethanol compared with Indolene and on S.G. plus 10 percent Ethanol compared with S.G. indicated that the driveability was the same in some cases and slightly degraded (hard to start and stalling when cold) in other cases. Thus these "mixed" gasohols did not pose the driveability problem that the "blended" gasohol did.

It is not known if a decreased volatility gasohol could be blended which would not cause an increase in evaporative emissions or degradation in driveability on in-use vehicles. The "blended" gasohol (Fuel 6) used in this program did result in increased evaporative emissions over Fuel 3 even though its RVP and distillation curve were adjusted close to that of Fuel 3.

Other considerations regarding the use of Ethanol in gasoline, such as emission system deterioration, fuel system compatability, or cost of production were beyond the scope of this program and were not addressed.

Appendix A.
Test Procedure

Gasohol Test Sequence

1. Drain and refuel to 20% tank capacity.
2. Run 1 LA-4 cycle.
   a. Check idle CO and RPM first time on each fuel.
3. Hot soak one hour (key off to key on).
4. Drain and refuel to 40% tank capacity.
5. Run 1 LA-4 cycle.
6. Soak 12-24 hours @ 68-86F (key off to key on).
7. Run 1 FTP with SHED:
   a. Drain and refuel to 40% tank capacity (leave fuel cap off).
   b. Move vehicle to SHED.
   c. Weigh cannister.
   d. Check cannister lines.
   e. Perform 1 hour diurnal heat build. (Fuel cap on @ 60°F.)
   f. Immediately after heat build:
      -Remove heat blanket
      -Weigh cannister
      -Reinstall cannister & check cannister lines.
   g. Run 3 bag FTP emissions test within 15-60 minutes of end of diurnal test.
   h. Run 1 hour hot soak immediately following emissions test.
   i. Weigh cannister immediately following hot soak test.
8. Precondition for next test:
   a. If within 24 hours of FTP key off go to step 4.
   b. If longer than 24 hours since FTP key off go to step 1.
   c. If changing fuel type go to step 1.
9. Two tests for each fuel type with following sequence:
   1,2,3,4,6,3 for group 1 vehicles.
   3,4,6,3,1,2 for group 2 vehicles.
   (6 fuel runs X 2 tests each X 11 vehicles = 132 tests)

Appendix B.
Test Fuel Data

Typical Fuel Inspection Data

ITEM	Analyzed by 1/	Fuel 1 EPA	Fuel 2 EPA	Fuel 3 Howell	Fuel 4 Howell	Fuel 5 Howell	Fuel 6 Howell	Nat'l. Avg. 2/	Calif. 2/
1. API Gravity	H-3,4,5,6	-	-	57.5	56.5	61.0	52.6	59.3	57.7
2. Sp. Gr.	C	-	-	0.749	0.753	0.735	0.769	.742	.748
3. R.O.N.	E-1,2,3,4 H-5,6	98.0	100.5	92.0	95.4	95.5	96.4	92.9	93.2
4. M.O.N.	H-3,4,5,6	-	-	82.6	84.2	88.1	88.6	83.9	84.7
5. Ole. %	E-1 H-3,4,5,6	2.5	-	16.5	16.6	0.4	17.6	7.2 4/	-
6. Aro. %	E-1 H-3,4,5,6	24.0	-	28.5	28.9	23.0	34.6	30.8 4/	-
7. RVP, PSI	M-1-6	9.0	9.2	10.0	10.7	7.9	10.0	9.8	8.4
8. Dist., F, 3/									
IBP		87	94	89	86	107	94	89	94
10%		128	130	119	118	126	126	121	126
20%		162	147	142	132	136	139	146	147
30%		194	156	167	144	145	150	171	168
40%		215	179	196	154	152	162	-	-
50%		229	220	227	201	205	242	221	216
60%		240	234	255	243	232	280	-	-
70%		253	245	287	272	260	311	266	275
80%		274	265	321	314	295	335	-	-
90%		313	309	360	355	321	370	333	344
EP		383	386	417	413	337	408	410	413

1/ H = Howell Hydrocarbons, Ethyl = Ethyl Cord, M = EPA-MVEL, D = D.O.E. Fuel Survey, C = Calculated value.
2/ D.O.E. Fuel Survey, Summer, 1977.
3/ Fuels 1-6 were analyzed by EPA.
4/ MVMA Fuel Survey, Summer, 1977.

Appendix C.
Vehicle Specification

VEHICLE SPECIFICATIONS

Vehicle I.D.	71S42	8Y2-2.3-C-122	80153	48257	8B1-302 F-97	9E2-2.3 F-85	88042	5944	ZL44ABD 159064	RH4168A 206799	79-FE-3
Vehicle Manufacturer	Ford	Ford	GM	GM	Ford	Ford	GM	GM	Chrysler	Chrysler	Toyota
Represented Car line	Thunderbird	Bobcat Wagon	Sunbird	Regal	Maverick	Pinto	Impala	Regal	Omni	Salon	Corolla
Model Year	79	78	78	78	78	79	77	78	78	78	79
Sales Class	Prototype	Cal. Light Duty Veh.	Cal. Light Duty Veh.	Cal. Light Duty Veh.	49 State Light Duty	49 State Light Duty	49 State Light Duty	49 State Light Duty	49 State Light Duty	49 State Light Duty	49 State Light Duty
Inertia Class	4500	3000	3000	3500	3500	2750	4000	3500	2500	4500	2500
Actual HP	13.1	10.3	11.4	12.2	9.7	9.7	13.3	12.2	7.3	12.3	9.0
Tire & Rim Size	GR 78x14	BR 78x13	A78 x 13	P95/75 R14	DR 78x14	A 78x13	GR78x15	P205/70R14	P165/75R13	F78x15	165R13
Engine Family	351 W	F2.3 BITR 80 R80	20X2CEE	940E2CYU	F302A1X95	2.3A1X92	910L4-42	940B2	P6-105-2KA	FD-318-2CA	21-C(F)
Engine Displacement	351 cu. in.	140 cu. in	151 cu. in.	232 cu. in.	302 cu. in	140 cu. in.	350 cu. in.	232 cu. in.	105 cu. in.	318 cu. in.	97 cu. in.
Configuration	V-8	In-line 4	In-line 4	V-6	V-8	In-line 4	V-8	V-6	In-line 4	V-8	In-line 4
Catalyst Type	3-way	3-way	3-way	3-way	OX-C	OX-C	OX-C	OX-C	OX-C	OX-C	OX-C
Carb.	2 BBL	2BBL	2BBL	2BBL	2BBL	2BBL	4BBL	2BBL	2BBL	2BBL	2BBL
Comp. Ratio	8.4	9.0	8.3	8.0	8.4	9.0	8.2	8.0	8.2	8.5	9.0
Ign. Timing	30 B	6 B	14 B	15 B	6B	6 B	6B	15 B	15 B	16 B	10 B
Timing RPM	550	650	1000	600	500	550	500	600	900	750	900
Transmission	Auto	Man. 4-speed	Auto	Auto	Auto	Man. 4-speed	Auto	Auto	Auto	Auto	Man. 5-speed

Appendix D.
Test Result Tables

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ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: DEC 15, 1978

VEHICLE: FORD T-BIRD (3-WAY) VIN: 71X42 INERTIA WT: 4500 ACTUAL HP: 13.1

TEST TYPE: FTP

FUEL	N		HC	CO	NOx	CO2	FE	BARO	HUM	NOxFC	DBL	HSL	TLOSS	TOTHC	BDBL	ABSL	AMSL	DDBL	DTEST
			<-GRAMS/MILE->				(MPG)	(IN-HG)	(GR H2O/LB DA)		<-GRAMS->								
1	2	MEAN	0.225	1.10	1.36	622.	14.2	29.32	63.15	1.05	1.29	0.80	2.09	6.51	1337.	1454.	1360.	21.4	-11.3
		ST. DEV	0.045	0.283	.254	1.	.0	0.212	5.548	0.023	0.45	0.10	0.55	0.07	0.71	.0	2.24	0.57	3.49
		C.V. %	19.7	25.7	18.7	0.1	0.0	0.7	8.78	2.47	35.1	12.4	26.4	1.10	0.05	.0	0.17	2.64	0.
2	3	MEAN	0.217	1.13	1.18	615.	13.9	29.10	76.32	0.99	1.30	1.82	3.11	16.41	1342.	1466.	1340.	23.7	-2.0
		ST. DEV	0.021	0.231	.015	4.	0.1	0.135	0.407	0.002	0.75	0.34	1.01	2.14	12.79	1.05	9.28	2.05	7.41
		C.V. %	10.1	20.4	1.3	0.6	0.8	0.5	0.53	0.18	57.7	18.6	32.6	17.28	0.95	1.03	0.69	8.66	0.
3	2	MEAN	0.250	1.50	1.17	617.	14.3	28.78	80.30	1.03	2.48	1.70	4.18	15.01	1362.	1491.	1352.	29.0	-9.2
		ST. DEV	0.014	0.283	.001	4.	0.1	0.071	1.687	0.008	0.51	0.04	0.47	0.74	3.67	1.58	2.74	1.98	0.78
		C.V. %	5.1	18.9	0.1	0.6	1.0	0.2	2.10	0.81	20.5	2.1	11.3	5.05	0.27	0.11	0.20	6.83	0.
4	1	MEAN	0.190	1.10	1.23	623.	13.7	29.23	81.15	1.03	1.78	1.88	3.66	15.38	1380.	1514.	1388.	34.0	7.7
6	3	MEAN	0.340	2.17	1.14	636.	13.3	29.13	73.91	1.00	1.25	1.97	3.23	17.35	1378.	1507.	1366.	29.3	-9.4
		ST. DEV	0.193	1.172	.035	3.	0.1	0.026	3.453	0.016	0.21	0.08	0.22	4.47	3.27	1.63	1.63	3.85	2.50
		C.V. %	47.5	54.1	3.0	0.4	0.4	0.1	4.67	1.61	17.1	3.8	6.8	25.74	0.24	0.12	0.12	13.12	0.
3	2	MEAN	0.270	1.10	1.24	634.	13.9	29.04	78.60	1.02	1.60	1.65	3.26	13.74	1376.	1507.	1370.	30.5	-6.2
		ST. DEV	0.014	0.141	.127	4.	0.1	0.162	0.403	0.002	0.04	0.02	0.06	0.31	1.41	1.87	7.18	0.28	4.05
		C.V. %	5.2	12.9	10.1	0.7	0.5	0.5	0.51	0.17	2.2	1.3	1.7	2.22	0.10	0.13	0.52	0.92	0.
4	1	MEAN	0.260	0.90	1.12	635.	13.4	29.38	71.70	1.00	0.95	1.62	2.57	12.49	1386.	1520.	1388.	34.1	-0.5

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 3.3 TRIPS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FID.)
   TOTHC= 3.3*(HC.G/MI)*DISTANCE + DBL + 3.3*HSL

THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MVEL
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
5. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: [illegible]

VEHICLE: 1980 HORCAT (3-WAY) VIN: RYC-2.3-C-123 INERTIA WT: 3000 ACTUAL HP: [illegible]

TEST TYPE: FTP

FUEL	N		EXHAUST HC	EXHAUST CO	EXHAUST NOX	EXHAUST CO2	EXHAUST FE	AMBIENT BARO	AMBIENT HUM	AMBIENT TEMP	SHED DBL	SHED HSL	SHED TLOSS	SHED TOTHC	CUMULATIVE RDBL	CUMULATIVE HSL	CUMULATIVE RMSL	CUMULATIVE RUNL	CUMULATIVE DRIVE
			GRAMS/MILE				(MPG)	(IN-HG)	(GRAINS/LB)		GRAMS								
1	2	MEAN	0.645	2.10	0.94	394.	22.1	29.25	52.66	0.91	0.76	1.07	1.84	10.38	743.	753.	731.	[illegible]	[illegible]
		STD. DEV	0.[illegible]21	0.283	.042	1.	.1	0.298	*****	0.046	0.45	0.13	0.58	0.82	3.67	.71	1.41	[illegible]	[illegible]
		C.V. %	[illegible].7	13.5	4.5	0.2	.3	1.0	****	5.10	58.2	12.5	31.5	8.09	0.49	.09	0.19	[illegible]2.6	[illegible]
2	3	MEAN	0.637	1.57	1.16	394.	21.9	29.13	72.29	0.99	1.37	2.19	3.27	14.19	740.	746.	733.	15.5	[illegible]7.4
		STD. DEV	0.115	0.379	.044	1.	.1	0.109	4.002	0.018	0.48	0.28	0.72	3.92	2.00	.91	0.41	1.15	[illegible].42
		C.V. %	[illegible]4.8	24.2	5.8	0.1	.3	0.4	5.54	1.84	45.0	12.8	22.1	27.65	0.27	.12	0.06	7.41	[illegible]
1	1	MEAN	0.190	1.80	0.95	396.	22.2	29.15	74.70	1.00	0.41	1.35	2.16	4.94	739.	751.	726.	12.4	[illegible]0.4
3	2	MEAN	0.270	2.35	1.11	397.	22.1	29.80	[illegible]0.15	1.02	1.19	1.73	2.82	13.49	736.	753.	726.	17.6	[illegible]7.5
		STD. DEV	0.[illegible]30	0.212	.021	3.	.1	0.043	1.455	0.002	0.03	0.30	0.28	[illegible].95	0.0	.0	2.55	[illegible].21	[illegible].[illegible]
		C.V. %	[illegible].1	9.0	1.9	0.7	.6	0.1	0.57	0.20	2.6	17.5	9.8	7.02	0.0	.0	0.35	1.24	[illegible]
4	2	MEAN	0.240	1.85	1.12	396.	21.4	29.11	[illegible]0.35	1.03	3.14	3.11	6.25	14.34	739.	748.	730.	[illegible]1.[illegible]	[illegible]7.1
		STD. DEV	0.[illegible]	0.071	.044	0.	.0	0.155	0.673	0.003	0.38	0.04	0.34	[illegible].20	1.00	.0	0.71	[illegible].24	[illegible].[illegible]
		C.V. %	[illegible].0	3.8	4.8	0.0	.0	0.5	[illegible].43	0.32	12.2	1.4	5.4	1.02	0.14	.0	0.10	1.63	[illegible]
6	2	MEAN	0.345	2.10	1.12	[illegible]11.	20.6	29.16	71.21	.98	2.42	2.66	5.59	20.02	744.	761.	733.	16.7	[illegible]1.1
		STD. DEV	0.[illegible]21	0.0	.042	3.	.1	0.011	3.023	0.014	0.13	0.12	0.25	[illegible].02	0.71	.71	1.41	[illegible].16	[illegible].[illegible]
		C.V. %	[illegible]6.3	0.0	3.7	0.7	[illegible].7	0.0	[illegible].24	1.40	4.4	4.5	4.4	[illegible].08	0.10	.09	0.19	[illegible].[illegible]	[illegible]
3	2	MEAN	0.290	2.10	1.05	[illegible]11.	21.4	29.05	75.30	1.00	2.27	1.96	4.23	14.96	739.	[illegible]	726.	17.[illegible]	[illegible]3.7
		STD. DEV	0.[illegible]09	0.424	.014	[illegible].	[illegible].4	0.141	[illegible].997	0.014	0.29	0.30	0.54	[illegible].00	1.73	[illegible].35	1.00	[illegible].71	[illegible].[illegible]
		C.V. %	11.1	20.2	1.3	1.4	1.7	0.5	[illegible].45	1.37	12.8	15.2	13.9	13.34	0.23	.31	0.14	[illegible].[illegible]	[illegible]

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 3.3 TRIMS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FID.)
TOTHC= 0.3*(HC.G/MI)*DISTANCE + DBL + 3.3*HSL

THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT E.A.MVL.
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
6. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: DEC 15, 197

VEHICLE: AM-SUNBIRD (2-WAY) VIN: A01S1 INERTIA WT: 3000 ACTUAL HP: 11.4

TEST TYPE: FTP

FUEL	N		EXHAUST HC	EXHAUST CO	EXHAUST NOX	EXHAUST CO2	EXHAUST FE	AMBIENT BARO	AMBIENT HUM	AMBIENT NOXFC	SHED DBL	SHED HSL	SHED TLOSS	TOTHC	CANISTER GRAMS DBL	CANISTER GRAMS HSL	CANISTER GRAMS AMSL	WEIGHTS DBL	WEIGHTS DTEST
			GRAMS/MILE				(MPG)	(IN-HG)	(GRAINS /LB)		GRAMS								
1	1	MEAN	0.210	4.50	0.65	428.	20.4	29.41	66.83	0.97	0.61	0.87	1.38	4.56	795.	407.	796.	12.8	3.0
2	2	MEAN	0.240	4.10	0.66	434.	19.4	29.04	66.10	0.97	0.69	1.88	2.57	12.62	812.	427.	824.	15.1	12.1
		STD. DEV	0.114	0.141	.042	10.	0.4	0.155	7.148	0.032	0.07	0.21	0.28	1.12	5.92	4.95	5.42	0.44	0.1
		C.V. %	47.1	3.4	6.4	2.3	2.2	0.5	****	3.25	10.2	10.9	10.7	8.92	0.73	1.60	0.72	2.96	0.9
1	1	MEAN	0.230	4.90	0.67	424.	20.5	29.09	74.02	1.00	0.56	0.87	1.43	4.14	810.	424.	811.	13.4	1.2
3	2	MEAN	0.335	5.90	0.69	418.	21.8	28.77	74.91	1.02	0.79	1.09	1.86	12.69	823.	441.	830.	18.3	7.3
		STD. DEV	0.161	0.141	.007	1.	0.1	0.070	4.679	0.023	0.17	0.07	0.24	0.15	4.64	4.69	4.69	0.07	0.7
		C.V. %	48.3	2.4	1.0	0.2	0.3	0.2	6.26	2.25	21.5	6.5	12.8	1.14	0.56	1.06	0.57	0.39	9.8
4	2	MEAN	0.350	6.40	0.71	416.	22.1	28.89	77.26	1.01	1.13	2.06	3.19	16.85	824.	446.	839.	21.4	15.1
		STD. DEV	0.057	0.707	.014	3.	0.1	0.085	3.107	0.015	0.24	0.04	0.28	1.30	5.00	5.00	1.87	0.44	0.3
		C.V. %	15.7	11.0	2.0	0.7	0.3	0.3	4.02	1.48	21.3	1.7	8.6	7.68	0.73	1.59	0.22	2.06	2.78
6	2	MEAN	0.310	7.40	0.74	430.	19.3	29.13	77.13	1.01	1.10	2.34	3.64	21.37	835.	455.	849.	20.6	9.8
		STD. DEV	0.071	0.283	.014	5.	0.2	0.016	1.960	0.009	0.08	0.78	0.71	0.72	0.71	1.00	1.00	0.89	1.41
		C.V. %	14.1	3.8	1.9	1.2	1.1	0.1	2.54	0.92	6.0	33.4	19.4	3.37	0.08	0.12	0.12	3.16	14.43
3	2	MEAN	0.240	5.75	0.74	428. 2	0.3	29.03	77.49	1.01	0.96	1.16	2.10	11.95	834.	453.	849.	19.3	8.3
		STD. DEV	0.0	0.071	.014	6.	0.3	0.155	2.982	0.014	0.13	0.04	0.06	0.27	1.87	2.35	3.61	0.44	1.70
		C.V. %	0.0	1.2	1.9	1.5	1.4	0.5	3.85	1.42	3.0	7.3	2.7	2.26	0.22	0.27	0.43	2.27	20.44

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 3.3 TRIPS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FI ...
TOTHC= 3.3*(HC.G/MI)*DISTANCE + DBL + 3.3*HSL
THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MVE...
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
5. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: DEC 15, 197

VEHICLE: GM REGAL #2 (3-WAY) VIN: 48257 INERTIA WT: 3500 ACTUAL HP: 12.2

TEST TYPE: FTP

FUEL	N		HC	CO	NOx	CO2	FE	BARO	HUM	NOxFC	DHL	HSL	TLOSS	TOTHC	BDAL	CANISTER WEIGHTS AHL	AMSL	DIHL	DTET
			GRAMS/MILE				(MPG)	(IN-HG)	(GRAINS /LB)		GRAMS								
3	2	MEAN	0.340	8.35	0.19	462.	18.6	29.36	76.14	1.01	3.63	1.14	4.77	17.06	956.	475.	955.	20.0	-0.3
		STD. DEV	0.028	1.061	.028	0.	0.1	0.090	1.369	0.006	0.39	0.13	0.25	0.65	1.58	0.71	2.65	0.76	1.6
		C.V. %	7.3	12.7	14.9	0.0	0.4	0.3	1.80	0.64	10.7	11.7	5.3	3.80	0.17	0.07	0.28	3.90	0.1
4	2	MEAN	0.405	7.90	0.25	459.	18.1	29.29	78.54	0.98	5.47	1.66	7.14	23.95	957.	491.	956.	24.5	3.1
		STD. DEV	0.035	0.283	.007	0.	0.0	0.120	3.324	0.015	0.37	0.39	1.36	3.12	0.0	2.45	1.00	1.48	0.7
		C.V. %	8.7	3.6	2.9	0.0	0.1	0.4	4.71	1.53	17.7	23.4	19.0	14.90	0.0	0.25	0.10	6.07	2.2
6	2	MEAN	0.555	10.60	0.31	476.	17.3	29.12	73.85	0.99	5.59	2.08	7.66	24.23	952.	473.	951.	21.5	-0.4
		STD. DEV	0.007	0.011	.014	0.	0.1	0.098	1.855	0.009	0.22	0.20	0.42	1.05	0.0	0.71	1.22	0.42	1.7
		C.V. %	1.3	0.1	4.6	0.0	0.8	0.3	2.51	0.86	3.9	9.5	5.4	4.02	0.0	0.07	0.13	1.97	0.
3	2	MEAN	0.430	10.05	0.27	469.	18.3	29.02	73.91	1.00	2.91	1.42	4.34	14.28	945.	467.	945.	21.7	-0.3
		STD. DEV	0.071	0.354	.007	1.	0.1	0.091	4.103	0.019	1.35	0.09	1.27	0.55	1.00	0.71	1.41	0.94	2.3
		C.V. %	16.4	3.5	2.6	0.2	0.4	0.3	5.55	1.92	46.3	5.5	29.3	3.01	0.11	0.07	0.15	4.30	0.
1	1	MEAN	0.400	8.30	0.18	470.	18.3	29.37	72.28	0.99	2.06	0.84	2.90	14.69	934.	449.	930.	15.3	-3.9
2	2	MEAN	0.315	6.35	0.24	462.	18.1	29.09	80.39	1.03	2.46	1.35	3.81	14.73	937.	456.	940.	18.4	2.7
		STD. DEV	0.007	0.212	.014	1.	0.0	0.474	*****	0.061	0.33	0.07	0.25	0.26	2.35	4.06	1.30	1.77	1.13
		C.V. %	2.2	3.3	5.9	0.2	0.1	1.6	****	5.90	13.2	5.2	6.7	1.75	0.25	0.43	0.11	9.63	41.1
1	1	MEAN	0.330	7.60	0.22	469.	18.4	29.58	74.91	1.00	1.77	1.12	2.89	14.13	939.	454.	934.	14.5	-5.5

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 3.3 TRIPS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FID.)
   TOTHC= 3.3*(HC.G/MI)*DISTANCE + DHL + 3.3*HSL

THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MV
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
5. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: DEC 15, 1975

VEHICLE: FORD MAVERICK (OX-C) VIN: AH1-302-F-97 INERTIA WT: 3500 ACTUAL HP: 9.7

TEST TYPE: FTP

FUEL	N		EXHAUST HC	EXHAUST CO	EXHAUST NOX	EXHAUST CO2	EXHAUST FE	AMBIENT BARO	AMBIENT HUM	AMBIENT NOXFC	SHED DBL	SHED HSL	SHED TLOSS	SHED TOTHC	CANNISTER WEIGHTS ADBL	CANNISTER WEIGHTS AHSL	CANNISTER WEIGHTS BHSL	CANNISTER WEIGHTS DUAL	CANNISTER WEIGHTS DTEST
			GRAMS/MILE				(MPG)	(IN-HG)	(GRAINS/LB)		GRAMS								
1	2	MEAN	0.680	5.05	1.34	547.	15.9	29.32	63.15	0.95	0.35	0.75	1.10	14.14	743.	755.	733.	12.5	-9.6
		STD. DEV	0.027	1.061	.042	8.	0.2	0.212	5.548	0.023	0.10	0.0	0.10	1.62	10.89	10.44	7.91	0.42	2.7
		C.V. %	3.8	21.0	3.1	1.6	1.3	0.7	8.78	2.47	28.3	0.0	9.0	4.47	1.47	1.38	1.08	3.39	0.
2	2	MEAN	0.730	3.50	1.46	535.	15.8	29.13	72.27	0.99	1.73	1.27	3.01	24.01	759.	772.	754.	12.8	-5.8
		STD. DEV	0.049	0.707	.071	4.	0.1	0.169	0.568	0.002	0.79	0.36	1.15	4.45	7.25	6.51	6.24	1.27	3.4
		C.V. %	13.4	20.2	4.8	0.7	0.4	0.6	0.79	0.25	45.8	28.3	38.4	18.53	0.95	1.10	0.98	10.10	0.
3	2	MEAN	0.830	9.40	1.39	539.	15.9	28.78	86.30	1.03	3.48	1.40	4.88	29.69	762.	777.	754.	14.7	-7.8
		STD. DEV	0.001	0.283	.014	0.	0.0	0.071	1.647	0.008	0.35	0.09	0.26	0.28	1.41	2.00	2.74	0.57	1.0
		C.V. %	0.1	3.0	1.0	0.0	0.1	0.2	2.10	0.81	10.2	6.5	5.4	0.99	0.19	0.26	0.36	3.85	0.
4	2	MEAN	0.825	4.75	1.55	535.	15.8	29.11	82.64	1.04	6.05	3.48	9.53	37.95	769.	783.	767.	14.3	-1.8
		STD. DEV	0.035	0.495	.035	4.	0.1	0.170	1.930	0.010	0.35	2.23	2.57	0.78	3.67	3.24	0.0	0.49	2.3
		C.V. %	4.3	10.4	2.3	0.7	0.4	0.6	2.34	0.94	5.7	63.9	27.0	17.87	0.48	0.41	0.0	3.47	0.
6	3	MEAN	1.570	8.20	1.55	541.	15.3	29.11	74.20	1.00	6.31	1.97	8.28	51.79	771.	744.	755.	12.9	-6.1
		STD. DEV	0.798	3.470	.095	7.	0.0	0.072	3.508	0.015	0.51	0.21	0.68	10.74	2.52	1.91	1.58	0.79	1.0
		C.V. %	50.8	42.3	6.1	1.3	0.1	0.2	4.72	1.53	8.1	10.7	8.2	20.19	0.33	0.24	0.21	6.15	0.
3	2	MEAN	0.730	7.05	1.40	550.	15.8	28.97	82.47	1.04	2.67	1.23	3.90	24.03	759.	776.	755.	17.0	-4.0
		STD. DEV	0.042	0.636	.085	6.	0.2	0.063	4.945	0.025	1.53	0.24	1.77	1.30	5.66	3.94	1.22	1.78	0.2
		C.V. %	5.4	9.0	6.1	1.0	1.3	0.2	6.04	2.43	57.2	19.5	45.3	5.00	0.75	0.51	0.16	10.4	0.

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 3.3 TRIPS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FI .)
TOTHC= 3.3*(HC.G/MI)*DISTANCE + DBL + 3.3*HSL

THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA NVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT E-A NVE
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
5. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: DEC 15, 197-

VEHICLE: FORD PINTO (OX-C) VIN: 9E2-2.3-F-85 INERTIA WT: 2750 ACTUAL HP: 9.7

TEST TYPE: FTP

FUEL	N		EXHAUST HC	EXHAUST CO	EXHAUST NOX	EXHAUST CO2	EXHAUST FE	AMBIENT BARO	AMBIENT HUM	AMBIENT NOXFC	SHED DBL	SHED HSL	SHED TLOSS	SHED TOTHC	CANNISTER BDBL	CANNISTER AHSL	CANNISTER AMSL	WEIGHTS DUBL	WEIGHTS DTEST
			GRAMS/MILE				(MPG)	(IN-HG)	(GRAINS/LB)		GRAMS								
1	2	MEAN	0.315	2.40	1.64	378.	23.1	29.25	52.66	0.91	1.07	0.58	1.65	15.64	783.	792.	772.	9.2	-10.8
		STD. DEV	0.007	0.283	.064	1.	0.1	0.296	*****	0.046	0.12	0.04	0.08	0.15	4.06	3.39	3.24	0.71	0.78
		C.V. %	1.4	11.8	3.9	0.4	0.3	1.0	****	5.10	11.2	7.3	4.7	0.96	0.52	0.43	0.42	7.64	0.
2	3	MEAN	0.473	1.90	1.87	373.	22.7	29.13	72.29	0.99	1.12	0.79	1.91	15.38	782.	792.	766.	10.6	-15.6
		STD. DEV	0.059	0.361	.105	3.	0.2	0.108	4.002	0.018	0.43	0.07	0.38	1.50	1.00	2.16	10.70	1.31	11.23
		C.V. %	12.4	19.0	5.6	0.7	0.9	0.4	5.54	1.84	29.6	8.5	20.2	9.76	0.13	0.27	1.40	12.35	0.
3	1	MEAN	0.830	3.50	1.78	378.	23.0	28.83	80.47	1.03	1.37	0.65	2.02	19.56	783.	795.	759.	12.1	-24.1
4	2	MEAN	0.610	2.65	1.89	377.	22.4	29.11	80.36	1.03	2.63	0.90	3.53	24.45	785.	801.	778.	16.0	-6.2
		STD. DEV	0.037	0.636	.001	7.	0.4	0.155	0.670	0.003	0.40	0.08	0.31	1.20	1.73	0.71	1.41	1.13	0.28
		C.V. %	4.6	24.0	0.1	1.9	1.6	0.5	0.83	0.32	15.1	9.4	8.8	5.88	0.22	0.09	0.18	7.07	0.
6	2	MEAN	0.760	2.70	1.99	397.	21.2	29.16	71.21	0.98	1.49	1.03	2.93	24.03	783.	799.	775.	16.3	-8.2
		STD. DEV	0.028	0.566	.049	6.	0.3	0.011	3.023	0.014	0.11	0.01	0.11	0.69	1.22	2.12	0.71	3.75	1.41
		C.V. %	3.7	21.0	2.5	1.4	1.3	0.0	4.24	1.40	8.0	0.7	3.6	2.88	0.16	0.27	0.09	22.92	0.
3	2	MEAN	0.615	3.45	1.96	396.	22.0	29.06	75.30	1.00	1.55	0.88	2.42	14.37	777.	797.	776.	20.1	-7.0
		STD. DEV	0.045	0.071	.042	2.	0.1	0.141	2.909	0.014	0.37	0.11	0.47	0.12	1.00	0.71	0.0	1.98	0.35
		C.V. %	7.3	2.0	2.2	0.5	0.6	0.5	3.86	1.37	23.7	12.1	19.5	0.84	0.13	0.09	0.0	9.85	0.

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 3.3 TRIPS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FID.)
   TOTHC= 3.3*(HC.G/MI)*DISTANCE + DBL + 3.3*HSL

THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MVE
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
5. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: DEC 15, 1978

VEHICLE: CHEV-IMPALA (OLDS-C) VIN: 8H042 INERTIA WT: 4000 ACTUAL HP: 13.3

TEST TYPE: FTP

FUEL	N		EXHAUST HC	EXHAUST CO	EXHAUST NOX	EXHAUST CO2	EXHAUST FE	AMBIENT BARO	AMBIENT HUM	AMBIENT NOXFC	SHED DBL	SHED HSL	SHED TLOSS	SHED TOTHC	CANNISTER BOBL	CANNISTER AHL	CANNISTER AMSL	CANNISTER DOBL	CANNISTER DTEST
			GRAMS/MILE				(MPG)	(IN-HG)	(GRAINS /LB)		GRAMS								
1	1	MEAN	0.40 0	6.20	1.61	603.	14.4	29.20	67.34	0.97	0.94	1.42	2.36	15.36	895.	409.	887.	13.5	-8.1
2	1	MEAN	0.340	3.30	1.31	609.	13.9	29.21	70.45	0.98	0.77	1.56	2.33	15.49	878.	898.	894.	20.1	6.0
3	2	MEAN	0.510	6.35	1.80	603.	14.4	29.38	75.99	1.01	1.77	1.47	3.24	16.95	897.	420.	894.	23.2	-3.1
		STD. DEV	0.014	0.212	.021	1.	0.0	0.083	6.853	0.033	0.14	0.04	0.18	0.65	0.71	0.0	0.0	0.14	0.71
		C.V. %	2.8	3.3	1.2	0.1	0.1	0.3	9.02	3.23	8.0	2.9	5.7	3.92	0.08	0.0	0.0	0.61	0.
4	2	MEAN	0.445	5.10	1.48	610.	13.8	29.31	73.71	0.99	3.45	1.84	5.30	21.76	904.	932.	907.	27.5	2.8
		STD. DEV	0.092	1.131	.001	0.	0.0	0.113	1.369	0.006	0.23	0.04	0.27	1.91	1.00	2.00	2.65	0.85	1.63
		C.V. %	18.6	22.2	0.0	0.0	0.1	0.4	1.86	0.64	6.8	1.9	5.1	7.77	0.11	1.21	0.29	3.07	57. 7
6	3	MEAN	0.343	5.50	1.52	624.	13.5	29.13	72.76	0.99	4.16	2.03	6.18	24.22	902.	429.	903.	26.4	0.4
		STD. DEV	0.046	0.400	.004	9.	0.2	0.081	7.461	0.034	1.55	0.05	1.59	6.72	3.21	4.28	2.92	3.74	2.42
		C.V. %	8.5	7.3	0.4	1.4	1.3	0.3	****	3.44	37.2	2.4	25.7	11.24	0.36	1.46	0.32	12.44	96. 6
3	1	MEAN	0.470	6.80	1.76	604.	14.4	29.04	64.57	0.98	2.26	1.43	3.69	14.53	902.	426.	900.	24.5	-2.3

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 1.3 TRIPS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FI.)
   TOTHC= 1.3*(HC.G/MI)*DISTANCE + DBL + 1.3*HSL
THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MVE
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
5. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: DEC 15, 1978

VEHICLE: BUICK REGAL (OX-C) VIN: 5946 INERTIA WT: 3500 ACTUAL HP: 12.2

TEST TYPE: FTP

FUEL	N		HC	CO	NOx	CO2	FE	BARO	HUM	NOXFC	DBL	HSL	TLOSS	TOTHC	RDBL	CANISTER BL	CANISTER AHSL	#FINTS DURL	#FINTS DTE-T
			GRAMS/MILE				(MPG)	(IN-HG)	(GRAINS /LB)		GRAMS								
2	1	MEAN	0.550	4.50	1.27	467.	18.0	29.16	74.70	1.00	1.55	2.00	3.55	21.11	824.	-44.	829.	20.2	5.3
3	2	MEAN	0.620	7.35	1.43	462.	18.6	29.38	75.99	1.01	3.19	1.22	4.32	22.37	836.	60.	835.	24.8	2.4
		STD. DEV	0.014	0.495	.014	3.	0.1	0.083	6.853	0.033	0.13	0.13	0.27	0.89	3.54	0.71	0.71	3.54	3.54
		C.V. %	2.3	6.7	1.0	0.6	0.4	0.3	9.02	3.23	4.3	11.0	6.2	3.98	0.42	0.08	0.08	14.25	*****
4	1	MEAN	0.570	5.00	1.36	469.	17.9	29.23	74.68	1.00	6.03	1.27	7.30	24.22	844.	-71.	851.	27.0	6.9
6	2	MEAN	0.730	6.70	1.46	479.	17.4	29.15	72.12	0.99	5.74	1.72	7.47	24.52	844.	67.	845.	23.0	4.3
		STD. DEV	0.028	0.005	.021	1.	0.0	0.105	*****	0.018	0.62	0.15	0.76	0.47	0.71	1.73	2.65	0.42	1.70
		C.V. %	3.9	0.1	1.4	0.3	0.0	0.4	****	4.04	10.7	8.6	10.2	1.58	0.08	0.20	0.31	3.67	39.47
3	1	MEAN	0.550	7.00	1.51	472.	18.3	29.04	69.57	0.98	3.70	1.13	4.83	20.99	838.	-62.	840.	23.7	2.0
1	1	MEAN	0.510	6.60	1.27	469.	18.4	29.37	72.24	0.99	1.43	1.25	2.68	20.28	827.	-44.	828.	16.7	0.5

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 3.3 TRIPS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FI.)
   TOTHC= 3.3*(HC.G/MI)*DISTANCE + DBL + 3.3*HSL

THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.7). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT E-A MVE
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
6. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: DEC 15, 1976

VEHICLE: CHRY. OMNI (OX-C) VIN: ZL44AH/150066 INERTIA WT: 2500 ACTUAL HP: 7.4

TEST TYPE: FTP

FUEL	N		EXHAUST HC (GRAMS/MILE)	EXHAUST CO (GRAMS/MILE)	EXHAUST NOX (GRAMS/MILE)	EXHAUST CO2 (GRAMS/MILE)	EXHAUST FE (MPG)	AMBIENT BARO (IN-HG)	AMBIENT HUM (GRAINS/LB)	AMBIENT NOXFC	SHED DBL (GRAMS)	SHED HSL (GRAMS)	SHED TLOSS (GRAMS)	SHED TOTHC (GRAMS)	CANNISTER BBL (GRAMS)	CANNISTER AHL (GRAMS)	CANNISTER AMSL (GRAMS)	#FUMIS DUEL (GRAMS)	#FUMIS DTEST (GRAMS)
2	2	MEAN	0.330	8.20	1.38	318.	25.8	29.04	69.10	0.97	1.55	4.08	5.61	22.42	562.	574.	570.	12.1	8.1
		STD. DEV	0.014	0.849	.049	0.	0.1	0.155	7.148	0.032	0.04	1.04	1.00	3.80	1.87	1.00	2.24	0.84	1.42
		C.V. %	4.7	10.3	3.5	0.0	0.5	0.5	****	3.25	2.7	25.5	17.8	16.94	0.33	0.17	0.39	5.29	5.14
1	1	MEAN	0.430	12.60	1.08	322.	25.8	29.09	74.02	1.00	1.02	1.57	2.54	16.85	557.	568.	560.	10.4	3.2
3	2	MEAN	0.575	19.55	1.06	321.	25.1	28.77	79.91	1.02	2.70	5.24	7.95	34.17	561.	575.	567.	13.0	8.1
		STD. DEV	0.021	0.778	.042	2.	0.3	0.070	4.674	0.023	0.64	0.15	0.49	0.47	1.22	1.41	0.0	0.35	1.06
		C.V. %	3.7	4.0	4.0	0.7	1.1	0.2	5.86	2.25	23.8	2.8	6.2	1.37	0.22	0.25	0.0	2.61	13.13
4	2	MEAN	0.340	10.35	1.34	324.	25.1	29.10	79.55	1.01	3.49	10.10	13.59	45.24	563.	578.	574.	14.0	11.3
		STD. DEV	0.042	1.909	.071	7.	0.3	0.212	2.104	0.010	0.25	0.44	0.69	1.81	2.35	2.00	1.87	0.20	0.35
		C.V. %	12.5	18.4	5.3	2.2	1.1	0.7	2.75	1.00	7.1	4.3	5.0	1.34	0.42	0.35	0.33	1.41	3.14
6	2	MEAN	0.375	8.65	1.44	338.	24.3	29.13	77.13	1.01	2.45	5.73	8.69	31.11	562.	575.	571.	13.4	9.2
		STD. DEV	0.021	0.213	.035	1.	0.1	0.018	1.960	0.009	0.40	0.08	0.23	0.87	2.00	1.87	0.71	0.20	1.06
		C.V. %	5.7	2.5	2.4	0.2	0.6	0.1	2.54	0.92	10.3	1.4	2.6	2.17	0.36	0.33	0.12	2.11	11.51
3	2	MEAN	0.475	16.45	1.05	325.	25.2	29.03	77.49	1.01	2.55	4.47	7.02	24.05	561.	574.	567.	12.0	8.0
		STD. DEV	0.007	0.919	.007	1.	0.1	0.155	2.982	0.014	0.33	0.58	0.91	2.06	1.41	1.58	1.22	0.21	0.7
		C.V. %	1.5	5.6	0.7	0.2	0.6	0.5	3.85	1.42	13.0	13.0	13.0	7.10	0.25	0.28	0.22	1.80	1.17
1	1	MEAN	0.410	12.50	1.00	331.	25.2	29.38	71.76	0.99	1.15	1.91	3.26	17.03	558.	569.	564.	10.7	4.4

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 3.3 TRIPS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FI.)
TOTHC= 3.3*(HC.G/MI)*DISTANCE + DBL + 3.3*HSL
THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MVEL.
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
5. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: DEC 15, 19

VEHICLE: PLY. SALON (0X-C) VIN: RH41GH4206799 INERTIA WT: 4500 ACTUAL HP: 12.3

TEST TYPE: FTP

FUEL	N		HC	CO	NOX	CO2	FE	BARO	HUM	NOXFC	DRL	HSL	TLOSS	TOTHC	CANISTER BDRL	CANISTER ADRL	CANISTER AHSL	WEIGHTS DDHL	WEIGHTS DTEST
			GRAMS/MILE				(MPG)	(IN-HG)	(GRAINS /LB)		GRAMS								
1	1	MEAN	0.770	17.10	1.65	607.	13.9	29.24	72.28	0.99	1.49	1.06	2.95	24.26	744.	760.	743.	15.7	-1.0
2	1	MEAN	0.330	8.80	1.93	613.	13.6	29.04	75.27	1.01	2.44	1.61	4.45	21.24	742.	762.	754.	17.0	11.2
3	2	MEAN	0.705	17.10	1.45	609.	13.9	29.36	76.14	1.01	5.47	1.40	7.27	24.40	758.	777.	760.	18.0	2.3
		STD. DEV	0.307	0.0	.007	1.	0.0	0.090	1.369	0.006	0.48	0.40	0.48	0.32	0.0	0.71	2.24	0.07	1.41
		C.V. %	0.9	0.0	0.4	0.2	0.1	0.3	1.80	0.64	14.9	28.3	6.6	1.09	0.0	0.09	0.29	0.36	84.85
4	2	MEAN	0.540	9.90	2.14	609.	13.6	29.29	70.54	0.98	10.08	2.38	12.43	32.54	765.	785.	774.	20.1	8.8
		STD. DEV	0.001	0.566	.028	1.	0.1	0.120	3.324	0.015	0.0	0.16	0.16	0.56	3.46	2.45	1.87	1.06	1.48
		C.V. %	0.2	5.7	1.3	0.2	0.5	0.4	4.71	1.53	0.0	6.8	1.3	1.72	0.45	0.31	0.24	5.29	14.78
6	2	MEAN	0.760	11.55	2.19	634.	13.1	29.12	73.46	0.99	9.78	1.86	11.14	34.16	763.	782.	767.	18.8	3.5
		STD. DEV	0.071	1.344	.071	2.	0.1	0.098	1.855	0.009	0.65	0.03	0.68	1.14	1.73	0.0	0.0	1.06	1.06
		C.V. %	9.3	11.6	3.2	0.3	1.1	0.3	2.51	0.86	7.0	1.5	6.1	3.33	0.23	0.0	0.0	5.66	29.98
3	2	MEAN	0.680	21.25	1.63	618.	13.5	29.02	73.91	1.00	5.45	1.45	7.40	31.91	754.	775.	757.	20.7	3.2
		STD. DEV	0.014	0.778	.021	1.	0.1	0.091	4.103	0.019	0.59	0.16	0.74	0.76	2.45	0.71	0.71	2.55	2.40
		C.V. %	1.6	3.7	1.3	0.1	0.5	0.3	5.55	1.92	9.9	10.7	10.0	2.38	0.32	0.09	0.09	12.30	92.3

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 1.3 TRIPS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FI .)
TOTHC= 1.3*(HC.G/MI)*DISTANCE + DHL + 1.3*HSL

THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MVE
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
5. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

ENVIRONMENTAL PROTECTION AGENCY
MOTOR VEHICLE EMISSION LABORATORY
ANN ARBOR, MICHIGAN

GASOHOL PROGRAM
AVERAGE TEST RESULTS

PROCESSED: DEC 15, 197-

VEHICLE: TOY. COROLLA (OX-C) VIN: 79-FE-1 INERTIA WT: 2500 ACTUAL HP: 0.0

TEST TYPE: FTP

FUEL	N		EXHAUST HC	EXHAUST CO	EXHAUST NOX	EXHAUST CO2	FE	AMBIENT BARO	AMBIENT HUM	NOXFC	SHED DBL	SHED HSL	SHED TLOSS	SHED TOTHC	CANNISTER BDBL	CANNISTER ABSL	CANNISTER AHSL	WEIGHTS DBRL	WEIGHTS DTEST
			GRAMS/MILE				(MPG)	(IN-HG)	(GRAINS /LB)		GRAMS								
1	1	MEAN	0.550	7.10	1.06	326.	25.2	29.24	72.28	0.99	0.48	0.60	1.58	16.53	1427.	1435.	1423.	8.1	-3.5
2	1	MEAN	0.570	4.90	1.36	326.	25.5	29.04	70.27	1.01	0.32	0.67	1.54	17.28	1425.	1435.	1422.	10.4	-2.4
3	2	MEAN	0.775	8.85	1.27	336.	25.2	29.32	73.25	0.99	1.39	0.89	2.28	23.50	1426.	1438.	1425.	11.6	-1.5
		STD. DEV	0.061	0.071	.007	0.	0.0	0.062	2.859	0.013	0.06	0.06	0.11	0.23	1.00	1.00	1.22	0.01	0.-1
		C. . %	2.7	0.8	0.6	0.0	0.0	0.2	3.90	1.33	4.1	6.4	5.0	0.98	0.07	0.07	0.09	0.10	0.
4	2	MEAN	0.710	5.80	1.44	324.	25.6	29.24	71.91	0.99	2.05	0.99	3.04	22.91	1425.	1440.	1424.	15.1	-0.3
		STD. DEV	0.057	0.0	.014	1.	0.1	0.112	1.641	0.006	0.12	0.11	0.23	0.96	0.0	0.0	1.00	0.57	0.-2
		C... %	8.0	0.0	1.0	0.2	0.3	0.4	2.28	0.77	5.9	10.7	7.4	4.18	0.0	0.0	0.07	3.75	0.
6	2	MEAN	0.800	6.70	1.47	338.	24.3	29.07	74.64	1.00	1.41	1.20	3.01	25.00	1422.	1434.	1420.	12.7	-1.6
		STD. DEV	0.001	0.283	.014	3.	0.2	0.112	0.188	0.001	0.10	0.06	0.04	0.06	0.0	1.00	0.0	0.71	0. 7
		C.v. %	0.1	4.2	1.0	0.8	0.9	0.4	0.25	0.10	5.5	5.3	1.2	0.22	0.0	0.07	0.0	5.57	0.
3	2	MEAN	0.740	9.30	1.01	339.	24.9	29.07	79.67	1.02	1.53	1.03	2.57	24.23	1421.	1433.	1421.	12.3	0.3
		STD. DEV	0.028	0.142	.346	4.	0.2	0.069	8.943	0.044	0.19	0.02	0.17	0.78	0.0	1.00	0.0	0.21	1.14
		C.v. %	3.6	1.5	34.1	1.0	0.8	0.2	****	4.30	12.4	2.0	6.6	3.20	0.0	0.07	0.0	1.72	*****

NOTES:
1. FUELS ARE PRINTED IN THE ORDER THAT THEY WERE RUN.
2. TOTHC IS THE TOTAL HYDROCARBONS EMITTED FOR 3.3 TRIPS/DAY. (NOT CORRECTED FOR ETHANOL RESPONSE OF FI .)
   TOTHC= 1.3*(HC.G/MI)*DISTANCE + DBL + 3.3*HSL
THE FUELS USED WERE:

1. INDOLENE (RVP=9.0). SOURCE: EPA MVEL LAB FUEL IN USE FOR CERTIFICATION TESTING.
2. 90% INDOLENE + 10% ETHANOL (RVP=9.3). SOURCE: BLENDED USING FUEL NO. 1 AND 200 PROOF ETHANOL AT EPA MVE
3. COMMERCIAL GASOLINE (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
4. 90% FUEL NO. 3 + 10% ETHANOL (RVP=10.7). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).
5. BLENDED GASOHOL CONTAINING 10% ETHANOL (RVP=10.0). SOURCE: HOWELL HYDROCARBONS (MSED ORDER).

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